



computational course
Computational systems biology for
complex human disease:
from static to dynamic
representations of disease mechanisms

4–9 December 2022
Wellcome Genome Campus, UK



Network Analysis Using Cytoscape

WTAC

Computational Systems Biology for Complex Human Disease

Dr Anna Niarakis

Hinxton campus, Monday 5th of December 2022



Network visualization



Data Types in Cytoscape

- There are two types of data in Cytoscape
 - ***Network***
 - ***Attribute (Data Table)***



Cytoscape is for...

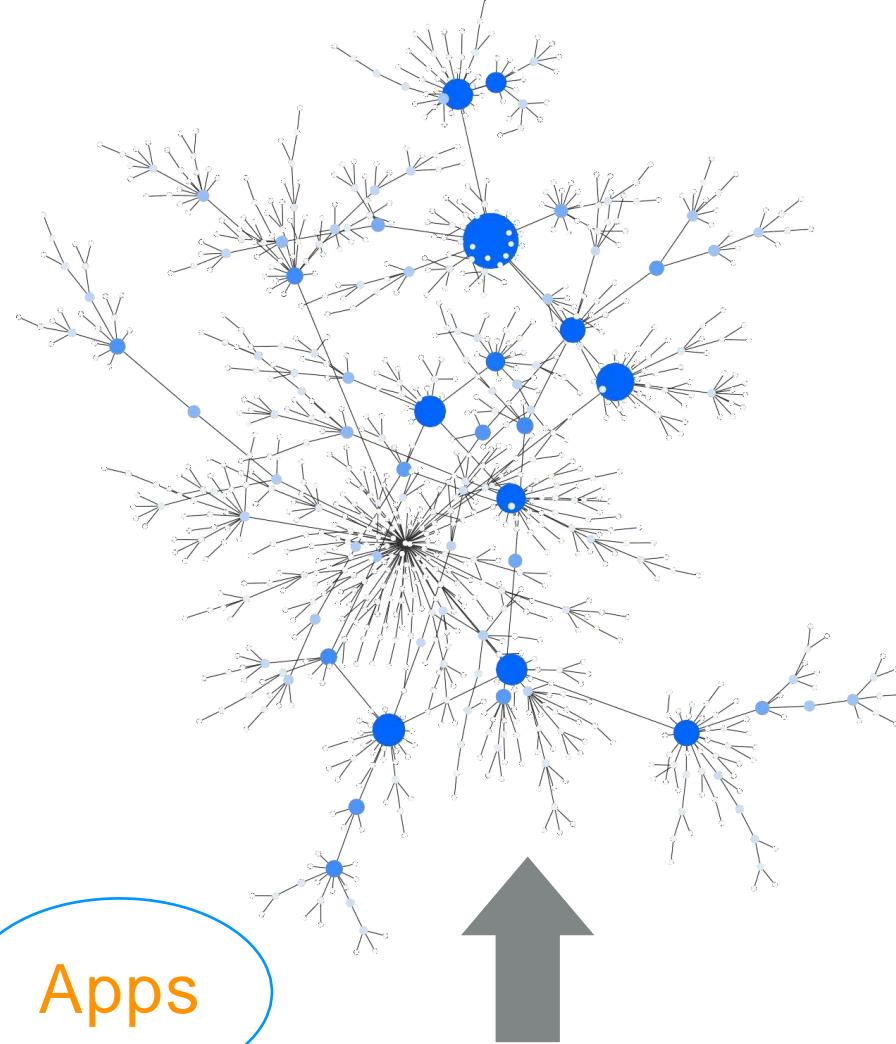
- Data integration
 - Join networks and attributes
 - Network data analysis
 - Visualization
- 

Network Data

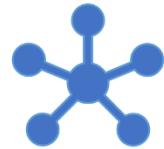
Attributes

Annotated Networks

Analyzed Data



Apps



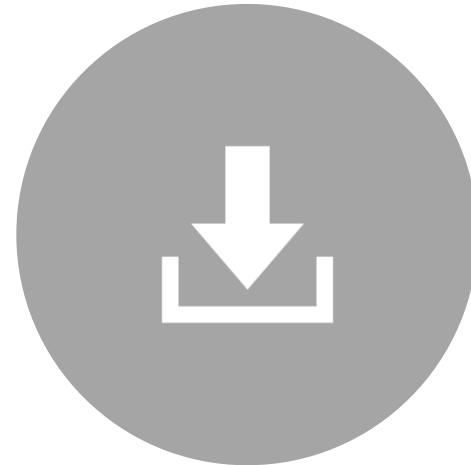
Attributes

- - Any data about nodes, edges, and networks.
- There are two types of data
 - Networks
 - Attributes
- Analysis and visualization will be performed for the integrated data (networks+attributes)

Saving & Opening



IN CYTOSCAPE, *SAVE* MEANS SAVING
YOUR WORKSPACE STATES INTO A
SESSION FILE



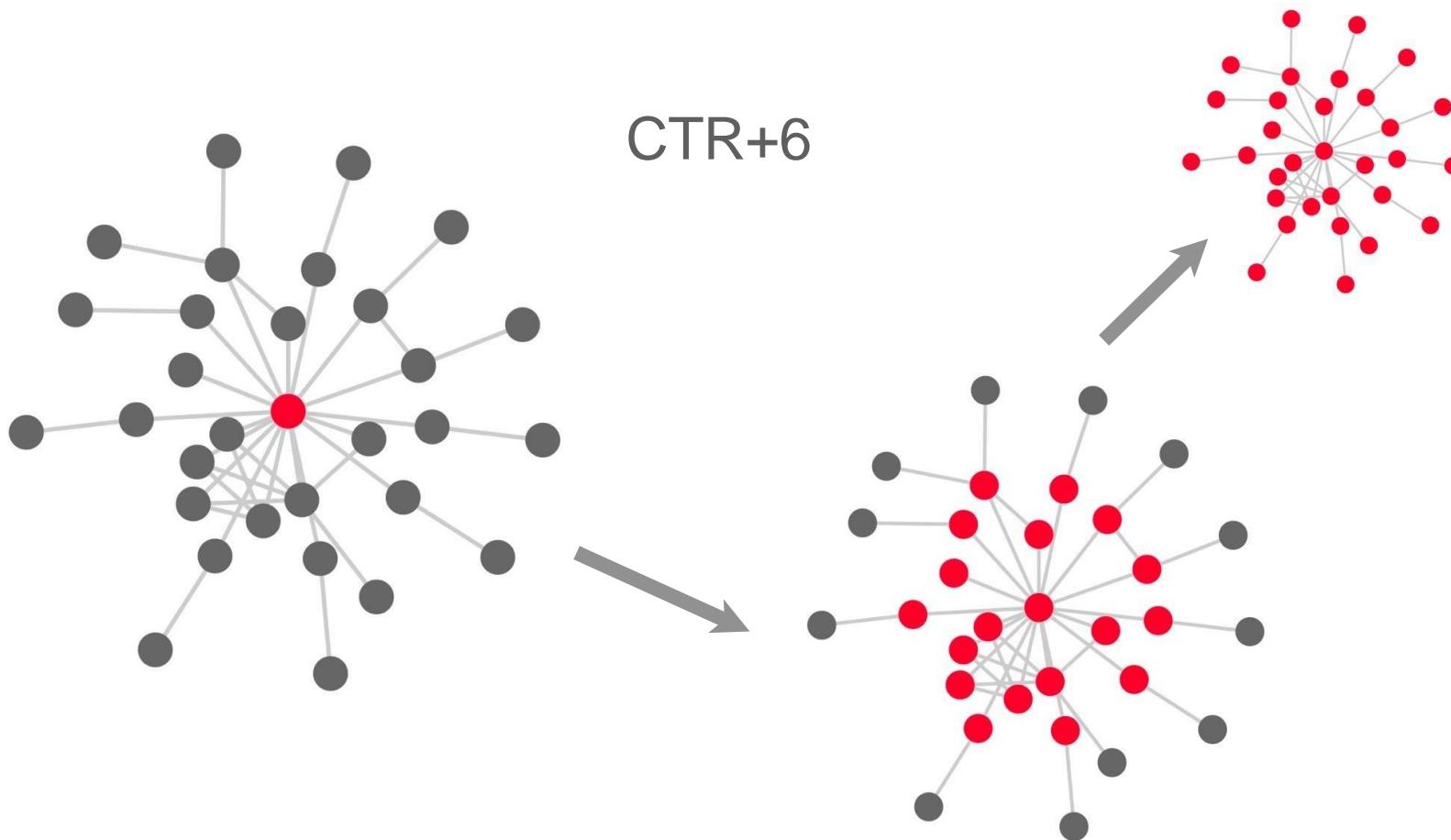
OPEN MEANS LOADING A SESSION FILE



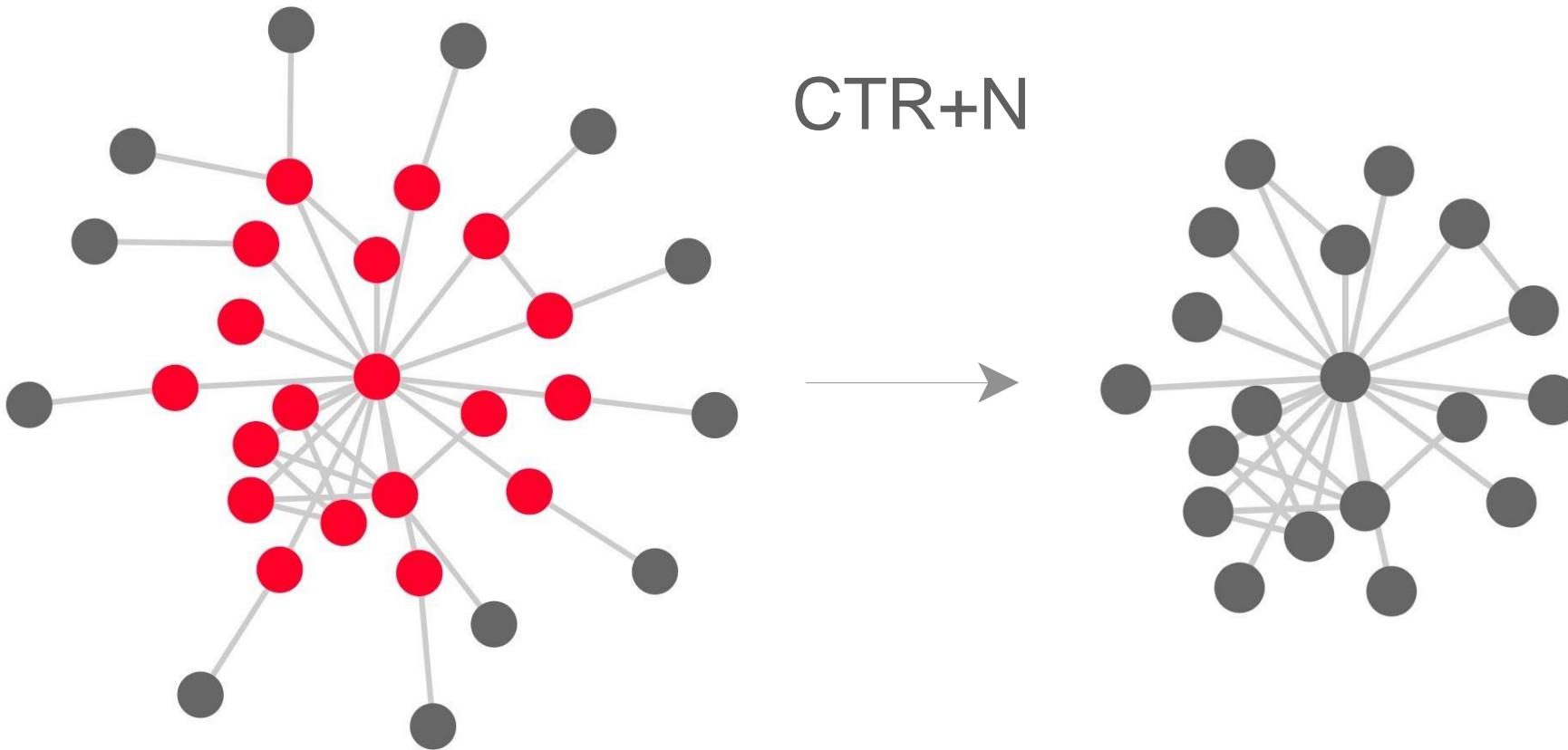
Useful Commands

- First neighbor of nodes
 - Create new sub-network from selection
 - Tile network views
 - Show Graphics Details
 - Linkouts
-

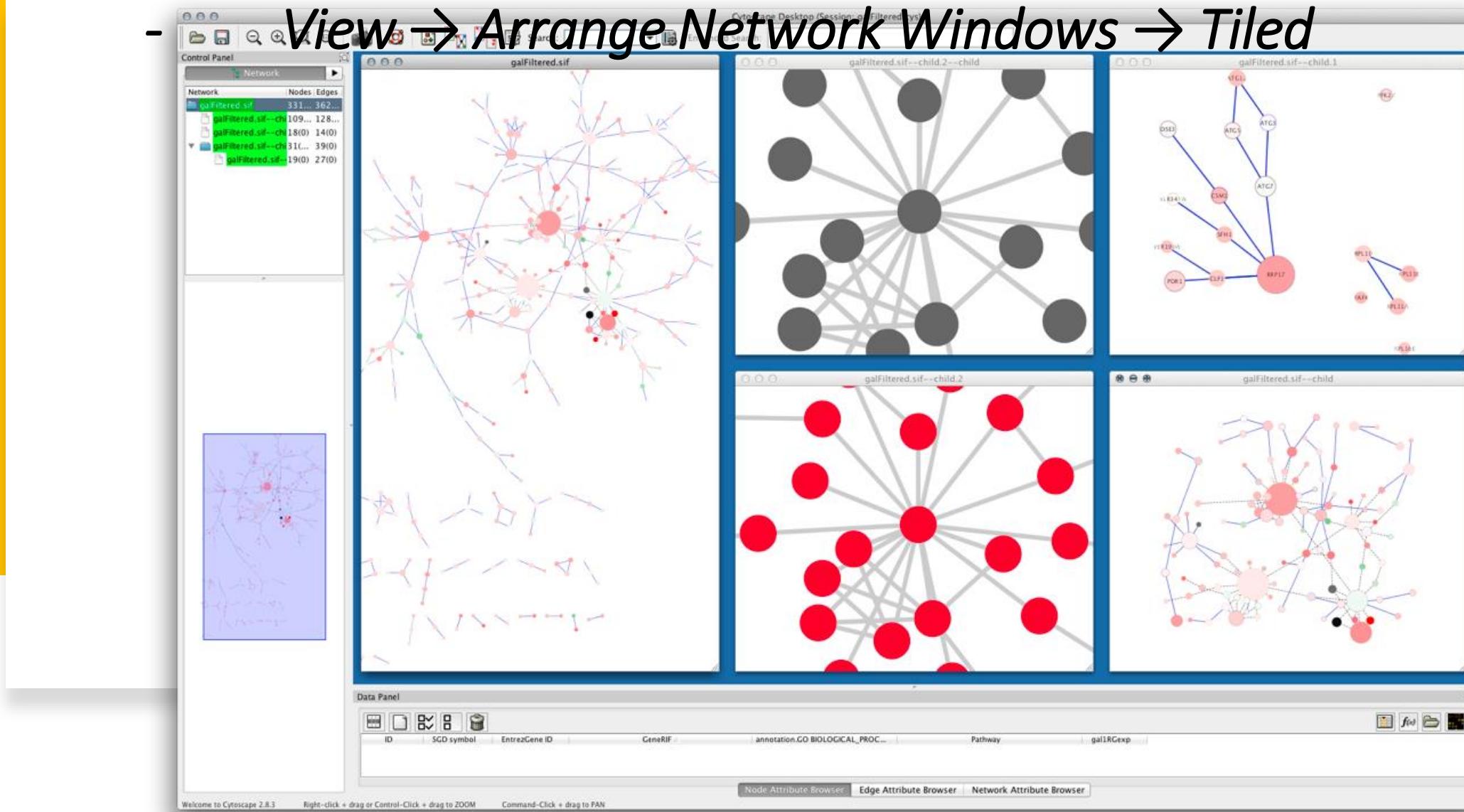
First Neighbor of Nodes



Create New Sub-Network From Selection

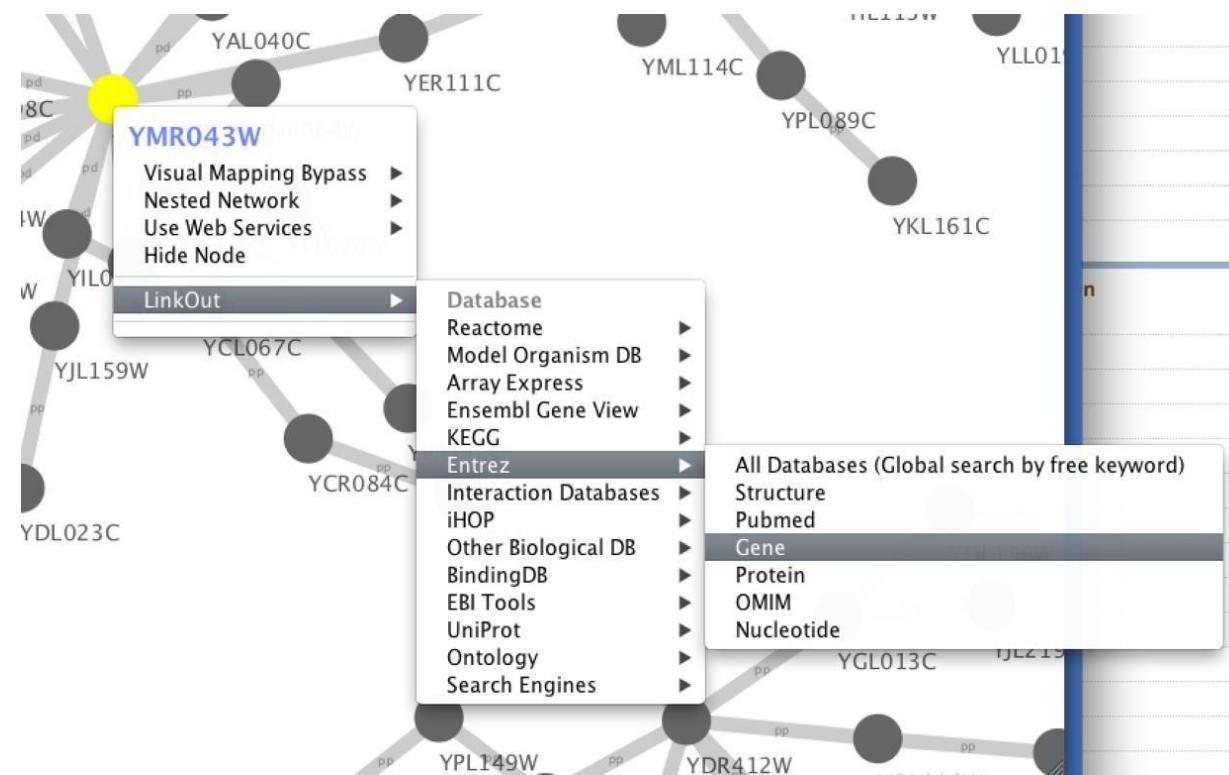


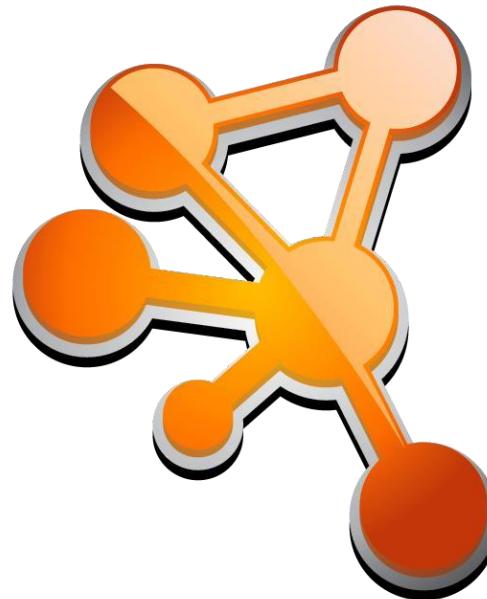
- View → Arrange Network Windows → Tiled



- Send ID as a query to external resources
- Opens a browser window and displays the result

Linkout





Data Integration



Import & Export

Import

Load any type of data

- Network, Attributes, Visual Styles, etc.



Export

as network files, tables, or
images

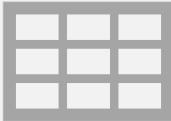
Network Data Formats

- SIF
 - GML
 - XGMML
 - GraphML
 - BioPAX
 - PSI-MI
 - SBML
 - KGML (KEGG)
-
- Excel
 - Delimited Text Table
 - CSV
 - Tab

Network Import

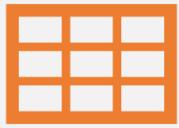


Usually, imported from pre-formatted data file



Or, use *Table Import* feature to select columns to be used as edges

Loading & Mapping Attributes



In most cases you
need to import
them from tables

e.g.
Expression
matrix saved
as Excel
workbook

Load Table as a Network



Simple list of binary interactions
can be loaded as networks

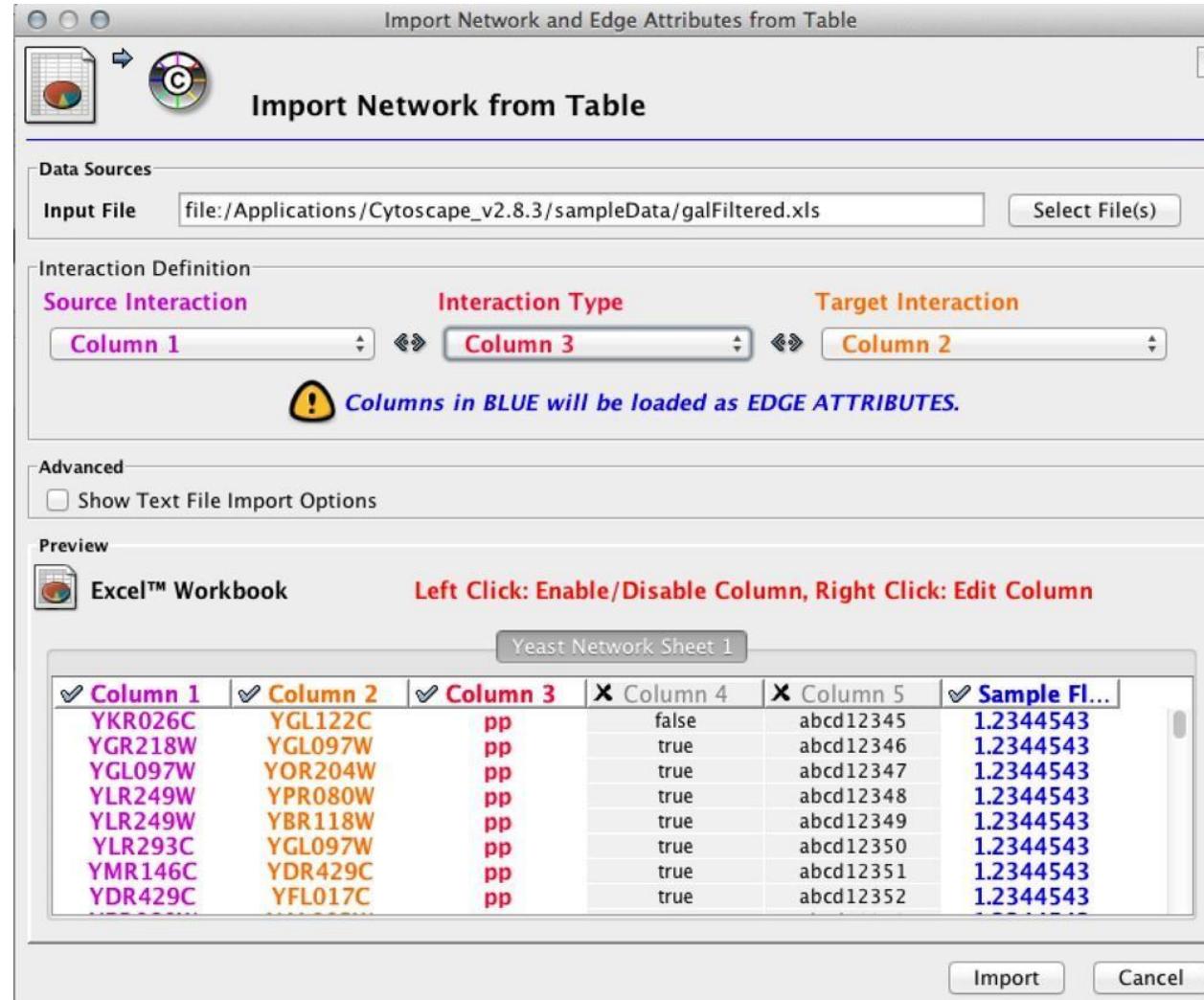


Source -Interaction Type - Target

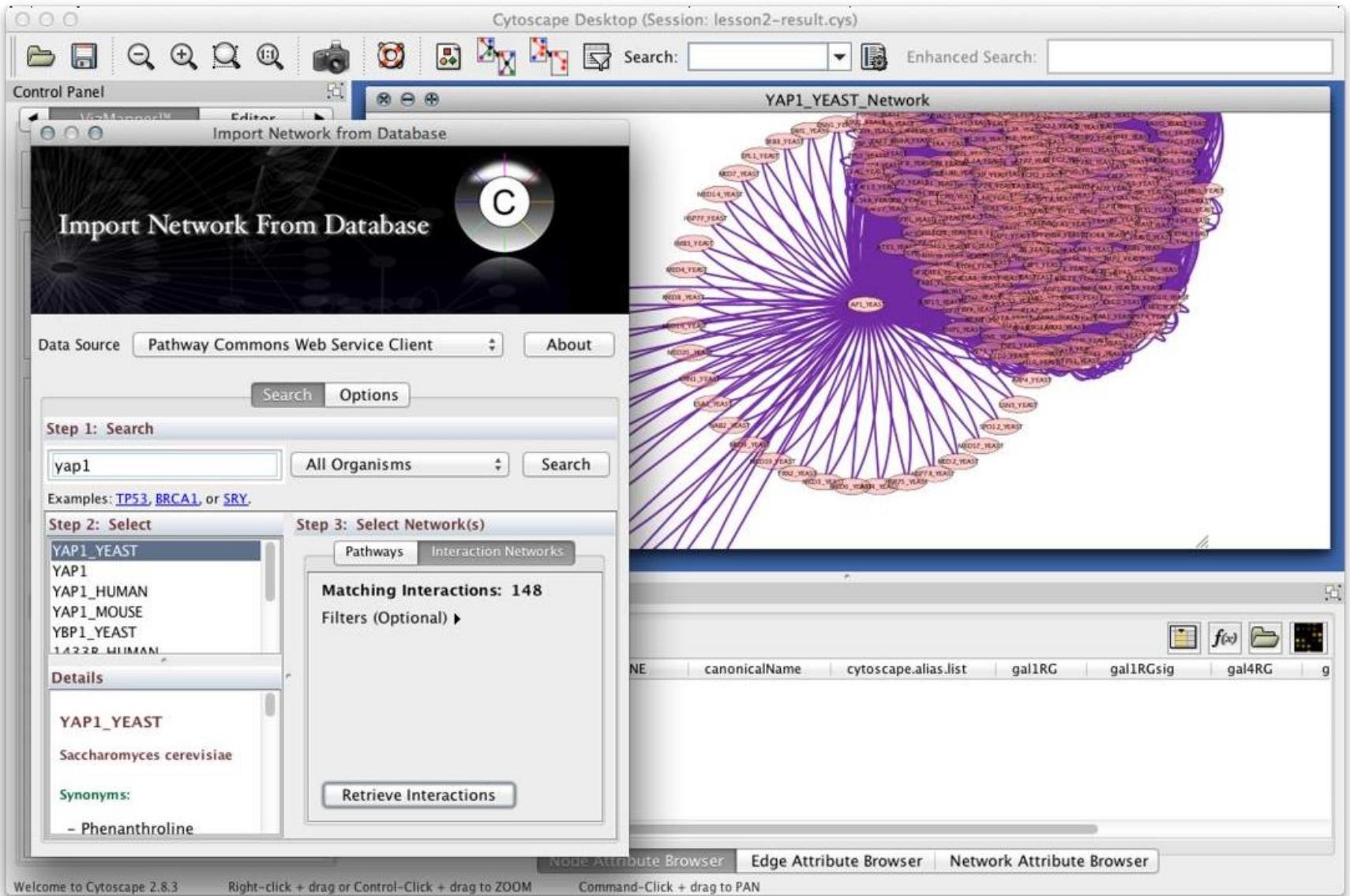


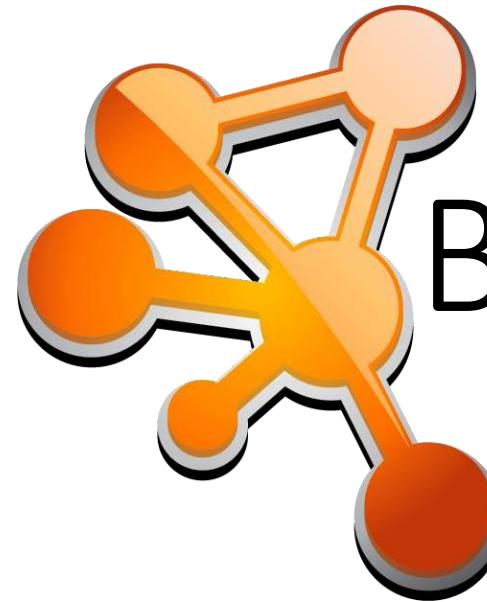
Or, *Source - Target*

Network from Excel File

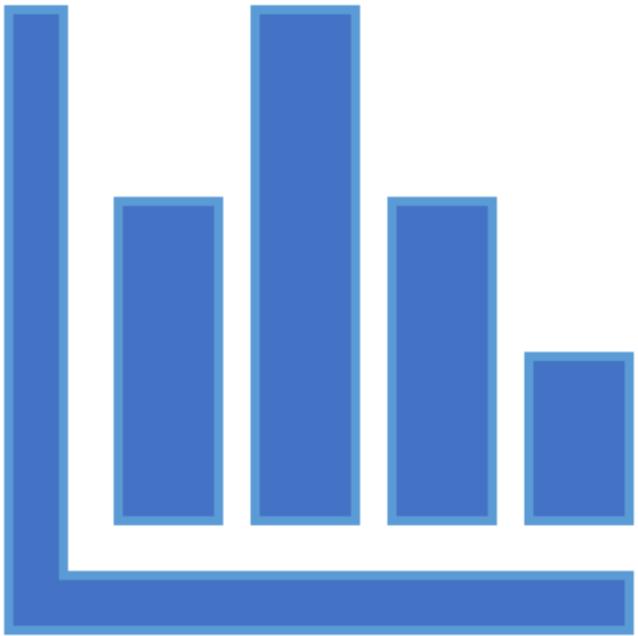


Network From External Data Source





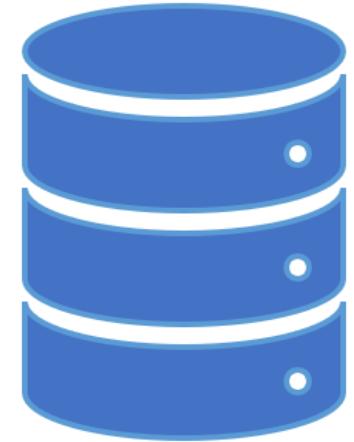
Basic Analysis



Network Statistics

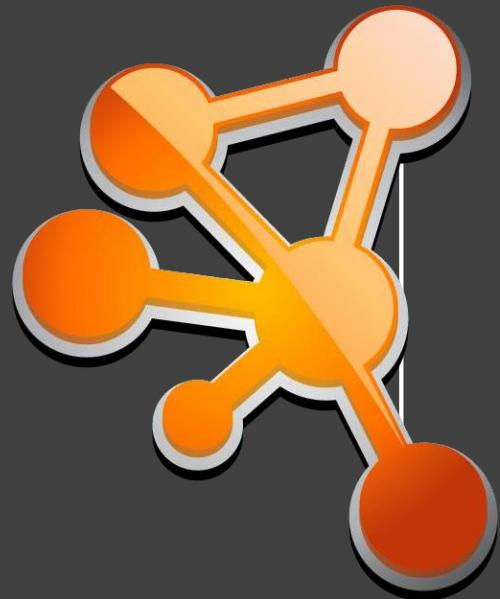
Network Statistics

NetworkAnalyzer provides all
results as regular attributes



Data Panel

ID	Degree	AverageShortestPathLength	BetweennessCentrality	ClosenessCentrality	ClusteringCoefficient	Eccentricity
YMR043W	18	5.84274194	0.5264582	0.17115252	0.05882353	15
YNL216W	17	6.29032258	0.35844736	0.15897436	0.0	16
YPL248C	11	6.63709677	0.05907389	0.15066829	0.17777778	15
YGL035C	11	5.85483871	0.40813644	0.1707989	0.05454545	14
YLR362W	9	6.86290323	0.22363878	0.14571093	0.02777778	15
YDR395W	8	8.15322581	0.05570067	0.12265084	0.0	18
YJR022W	7	11.13306452	0.12017603	0.08982253	0.0	24
YEL009C	7	7.62096774	0.06299561	0.13121693	0.0	18
YPL075W	7	7.49193548	0.18002254	0.13347686	0.0	18
YDR412W	7	7.13306452	0.30517827	0.1401922	0.0	17
YOR036W	6	8.24193548	0.13339563	0.12133072	0.066666667	17
YER133W	6	7.91935484	0.19096905	0.12627291	0.0	18
YCL067C	6	6.80645161	0.01614536	0.14691943	0.266666667	16
YGL073W	5	9.67741935	0.06332441	0.10333333	0.0	20
YGR009C	5	9.65322581	0.09214253	0.10359231	0.0	19
YFL017C	5	9.45564516	0.0426128	0.10575693	0.0	19
YIL061C	5	8.57258065	0.15820029	0.11665099	0.0	20
YNL189W	5	7.82258065	0.05593286	0.12783505	0.0	16
YOL051W	5	7.61693548	9.251E-5	0.13128639	0.4	16
YIP048W	5	7.56854820	0.04079818	0.12212572	0.2	16

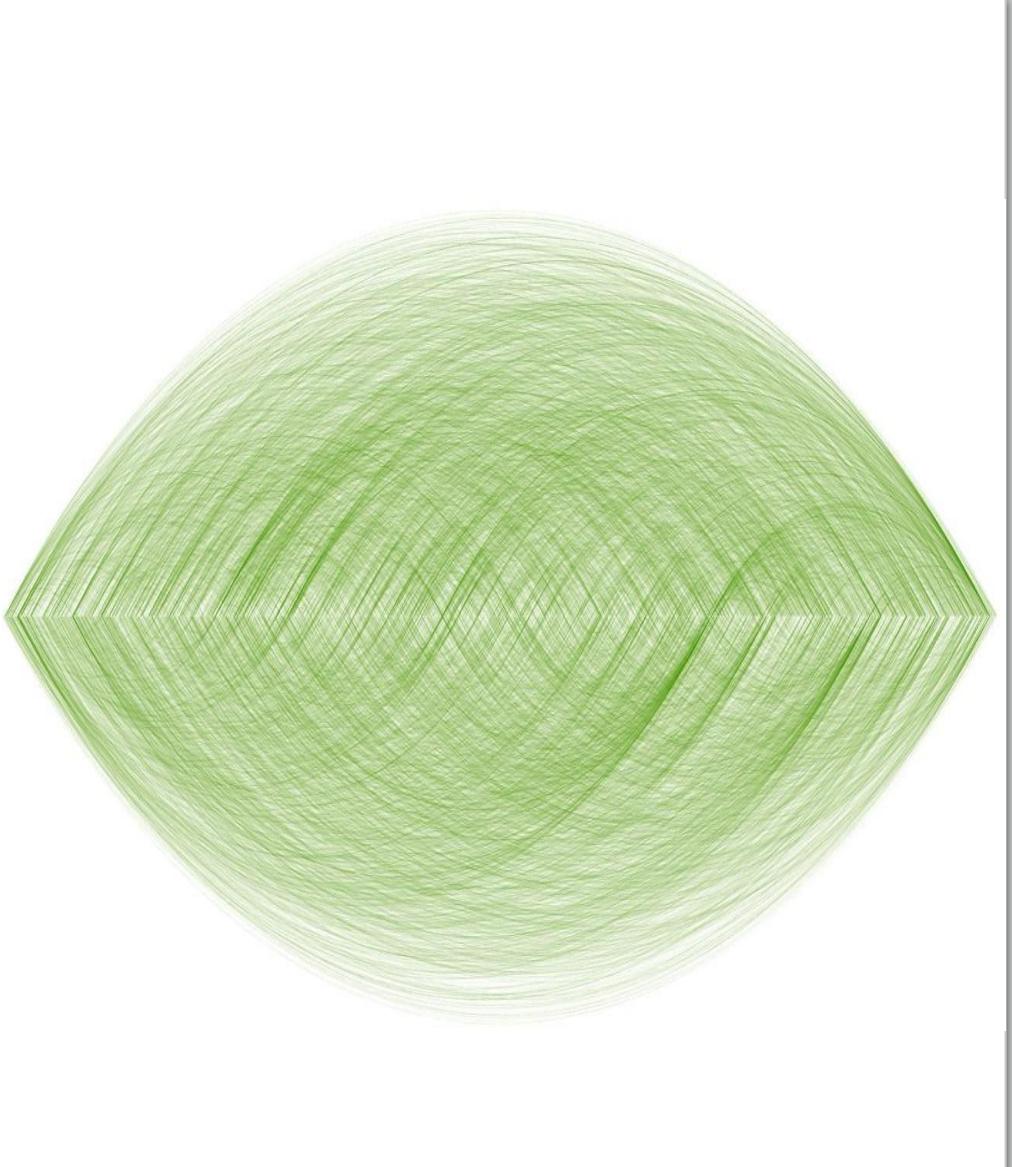


Visualization

Goal of Scientific Data Visualization



HELP SCIENTISTS TO
UNDERSTAND THEIR DATA SETS

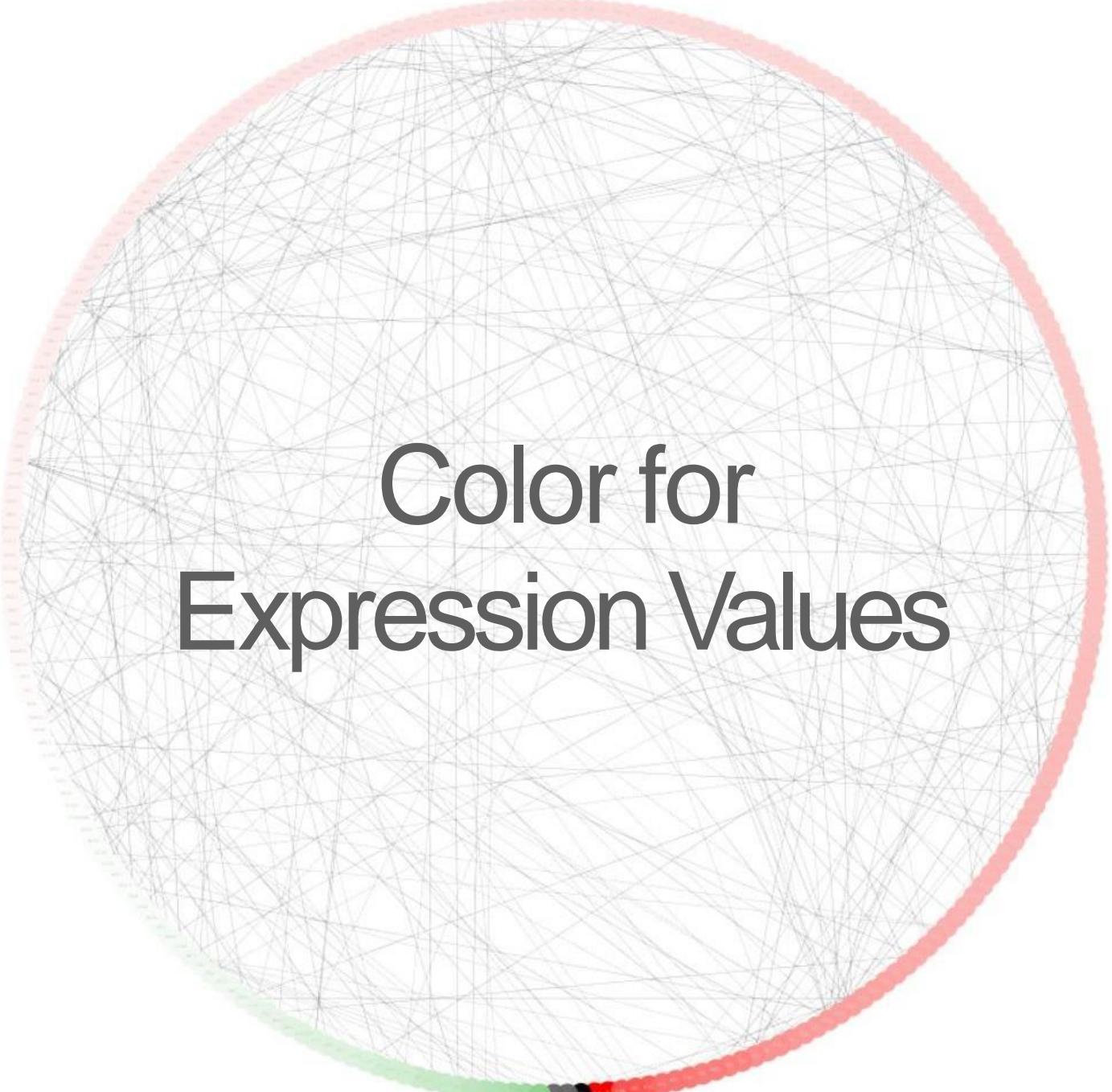


Large Scale
Visualizations are
Pointless in Many
Cases

Principles



TELL A STORY BY
VISUALIZATION

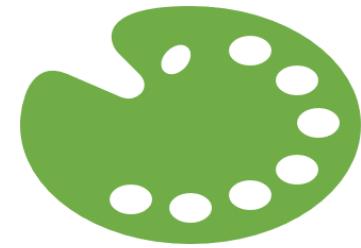
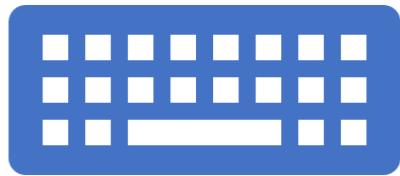


Color for
Expression Values



Edge Weight to Width

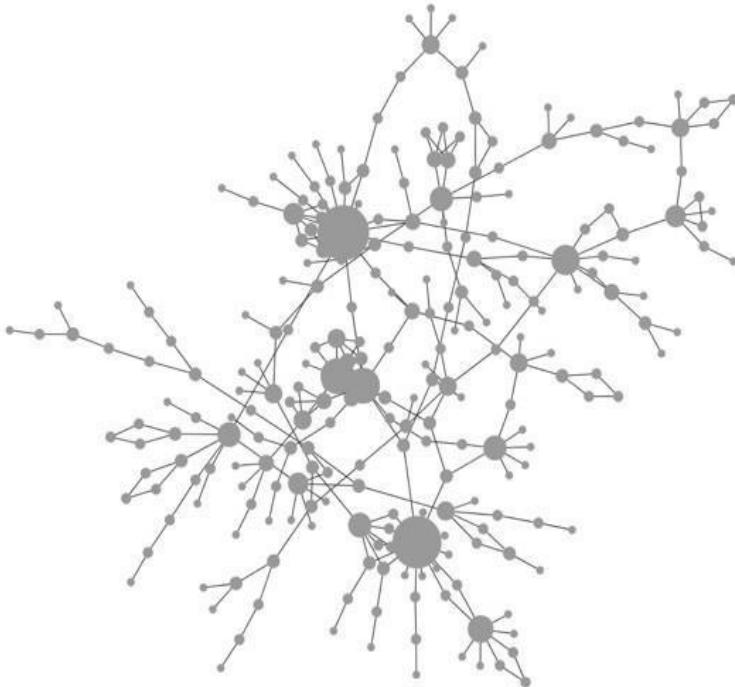
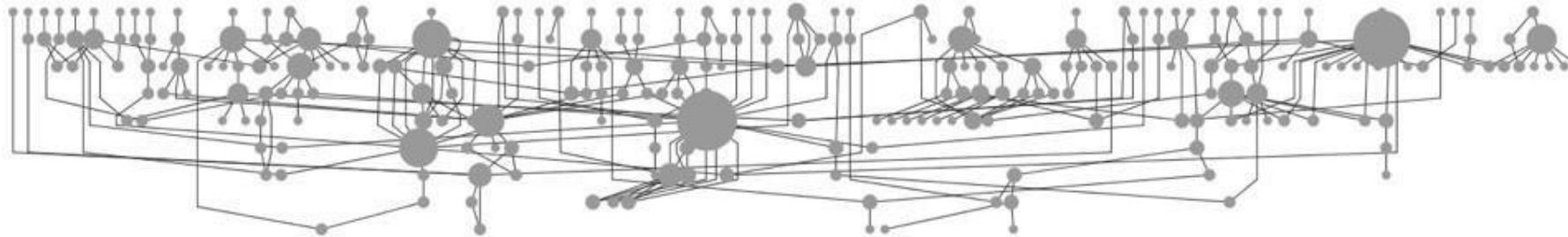
Elements of Network Data Visualization



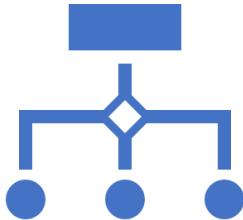
Layouts

Coloring

Layouts



Automatic Layout



Choose proper algorithm

Tree-like data - Hierarchical Layout

Scale-Free Network - Force-directed

Circular process - Circular Layout

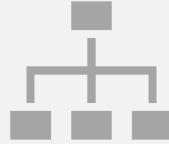


Tweak parameters if necessary

Coloring



Relatively lower accuracy
channel

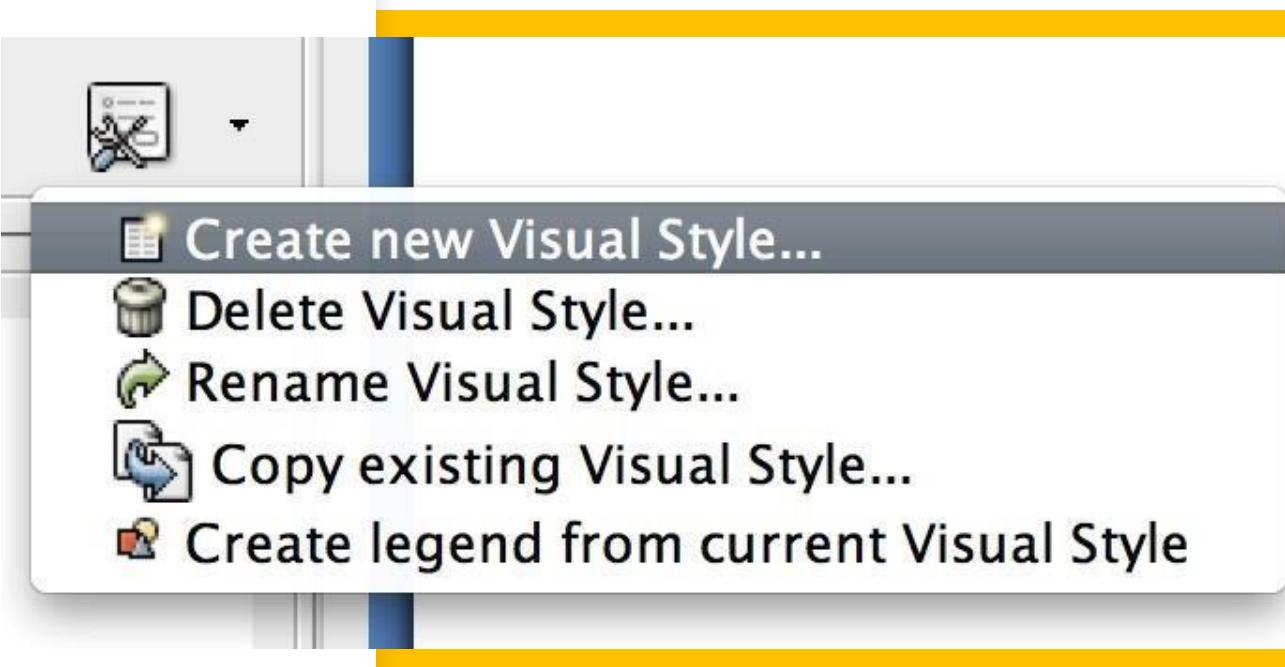


but still very important in network
visualization



Changes, Differences, Importance

Start
from a
clean
slate

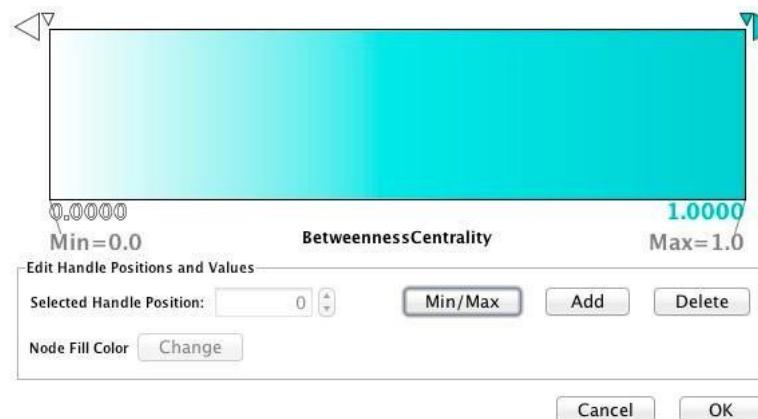


Map Attributes to Visual Properties

AverageShortestPathLength	Degree	BetweennessCentrality
4.66634317	2	3.204E-5
6.11083075	2	0.0
4.23156056	9	8.0508E-4
4.69448758	9	1.1543E-4
6.11083075	1	0.0
5.27697981	1	0.0
4.5320264	4	5.577E-5
4.66634317	7	0.00119994
4.62946429	3	5.363E-5
6.11083075	1	0.0
4.82861025	5	2.43E-5
4.24553571	10	9.205E-4
4.7828028	3	0.0
4.27717391	11	0.00180937
3.13159938	341	0.16425588
6.11083075	1	0.0
5.27697981	1	0.0
4.02600932	2	7.9141E-4

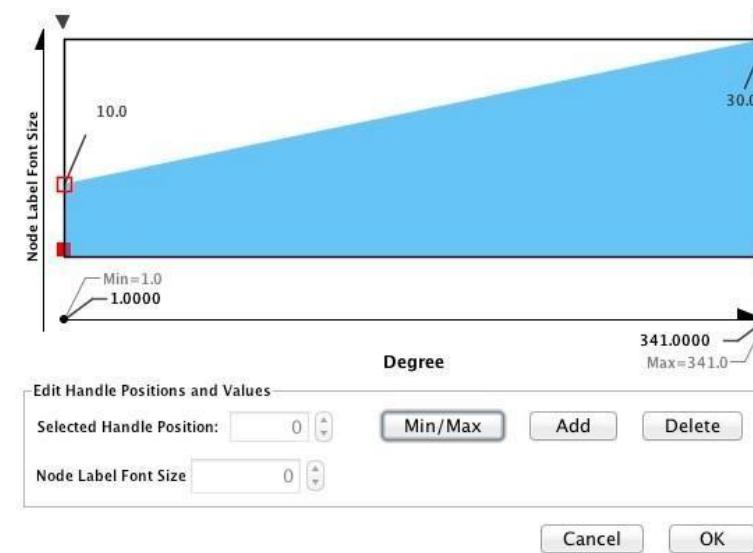
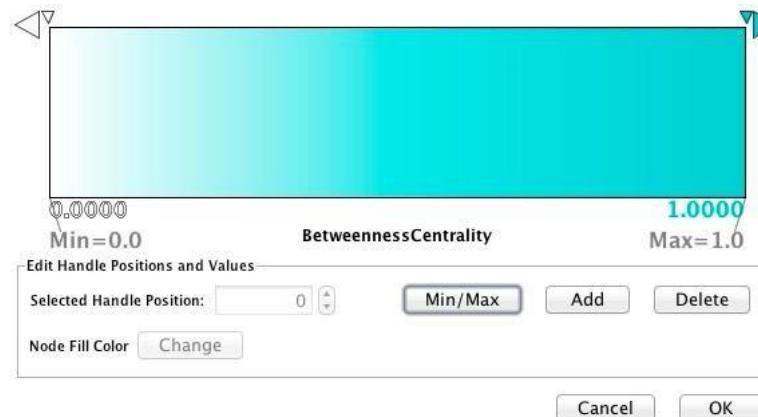
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Network VizMapper™ Editor Filters

Current Visual Style
galFiltered Style

Defaults

Visual Mapping Browser

Edge Visual Mapping

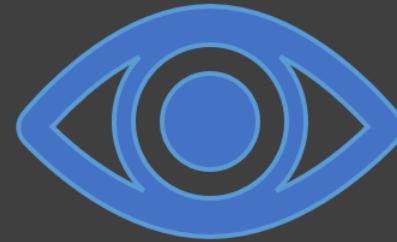
- Edge Color
 - Mapping Type: Discrete Mapping
 - pd: interaction
 - pp: interaction
- Edge Line Style: interaction

Node Visual Mapping

- Node Color
 - Mapping Type: Continuous Mapping
 - gal4RGexp: interaction
- Node Label: SGD symbol
- Node Size
 - Mapping Type: Continuous Mapping
 - Degree: interaction
- Node Tooltip: Pathway

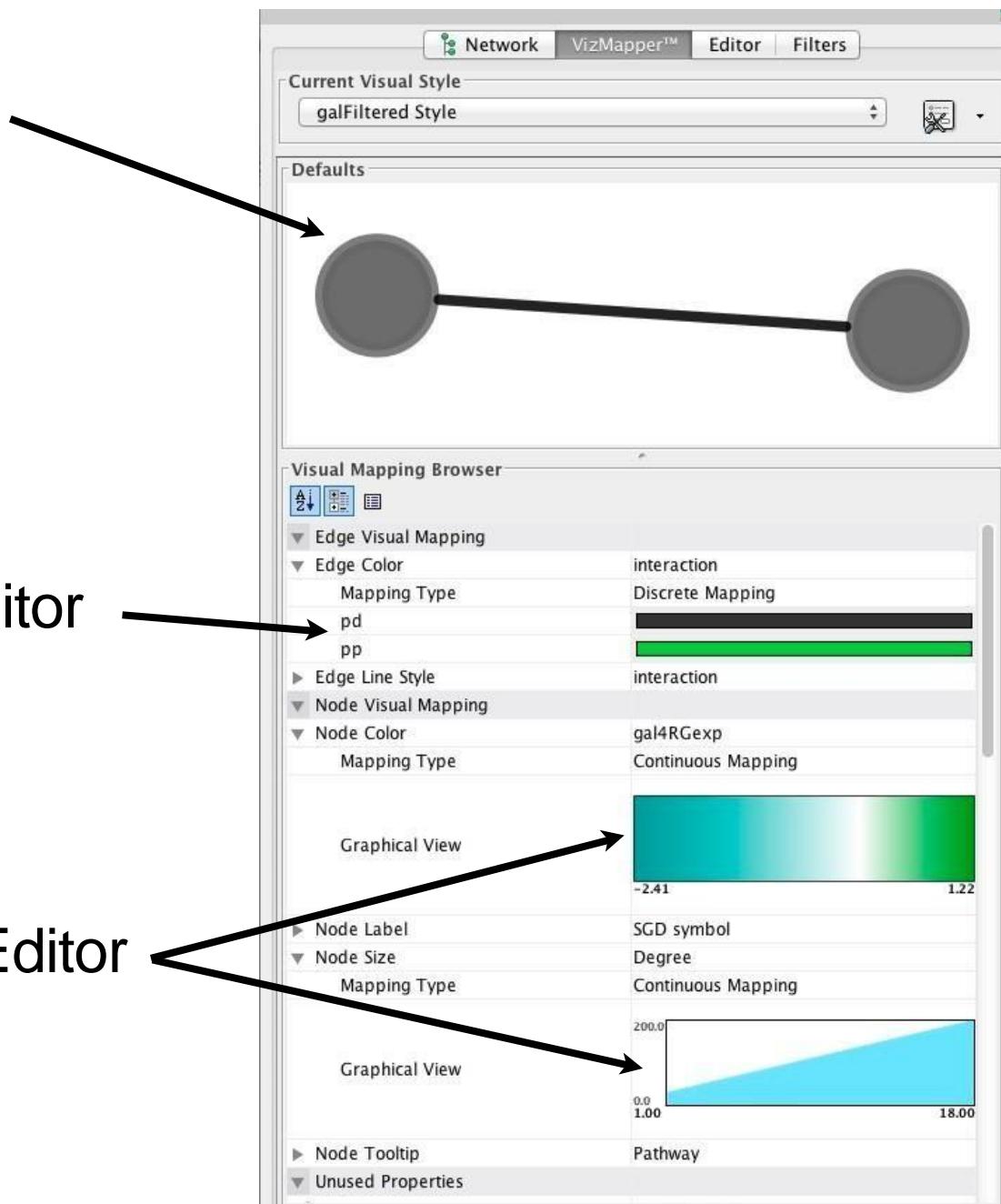
Unused Properties

Visual Style



- Collection of mappings from **Attributes** to **Visual Properties**

Default View Editor



Discrete Mapping Editor

Continuous Mapping Editor

Visual Mapping Browser



▼ Edge Visual Mapping

▼ Edge Color

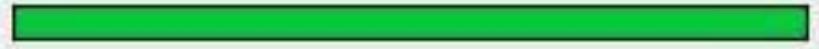
Mapping Type

interaction

pd

Discrete Mapping

pp



► Edge Line Style

interaction

▼ Node Visual Mapping

▼ Node Color

Mapping Type

gal4RGexp

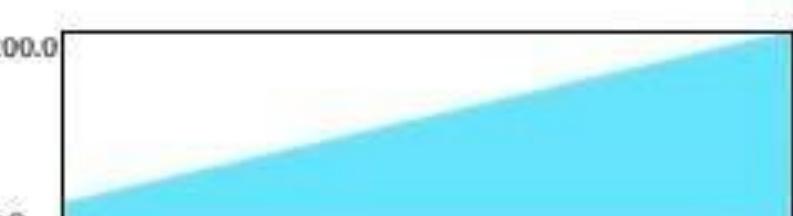
Continuous Mapping



Graphical View

-2.41

1.22

pp	
► Edge Line Style	interaction
▼ Node Visual Mapping	
▼ Node Color	gal4RGexp
Mapping Type	Continuous Mapping
	
Graphical View	
	-2.41 1.22
► Node Label	SGD symbol
▼ Node Size	Degree
Mapping Type	Continuous Mapping
	
Graphical View	
	200.0 0.0 1.00 18.00
► Node Tooltip	Pathway
▼ Unused Properties	

Session: New Session

File Edit View Select Layout Apps Tools Help

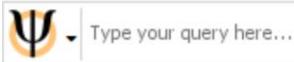


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Control Panel

Network Style Select

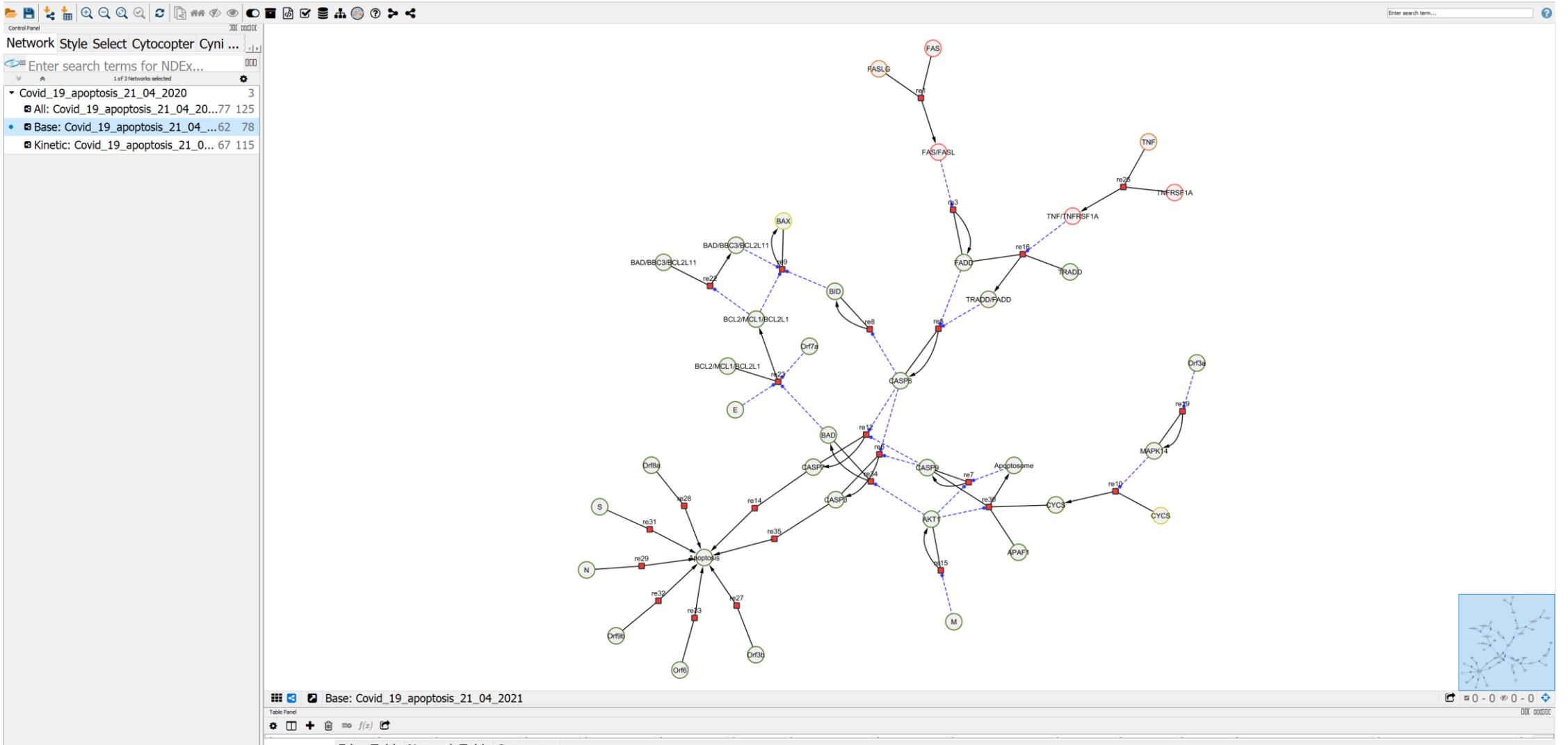


No networks selected



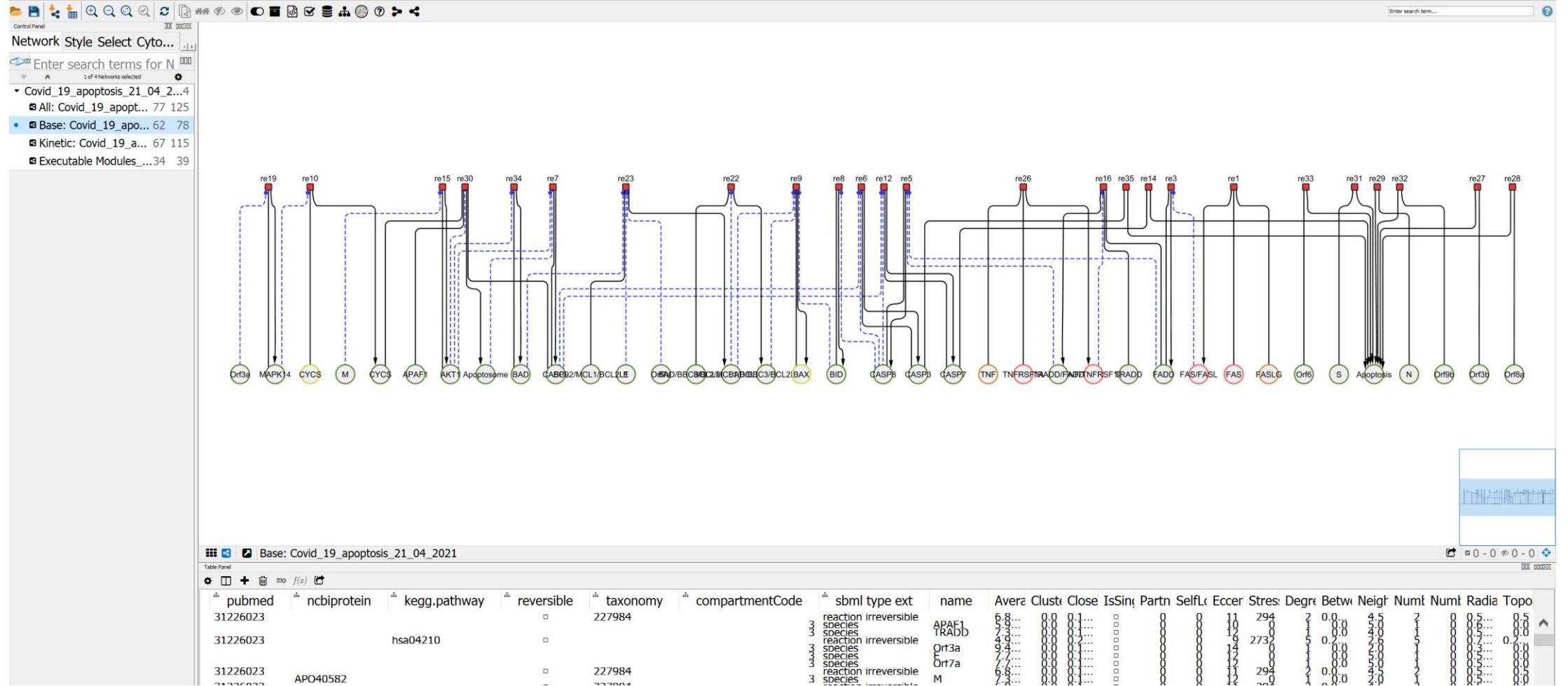
 Session: New Session

File Edit View Select Layout Apps Tools Help



Session: New Session

File Edit View Select Layout Apps Tools Help





Use Network
analyzer to
calculate statistics

